(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 680 790 A2**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **95104359.5**

(22) Date of filing: **24.03.95**

(51) Int. Cl.[6]: **B05B 7/08**, B05B 5/03, B05B 5/053

(30) Priority: **05.04.94 US 222897**

(43) Date of publication of application:
08.11.95 Bulletin 95/45

(84) Designated Contracting States:
BE CH DE ES FR GB IT LI NL

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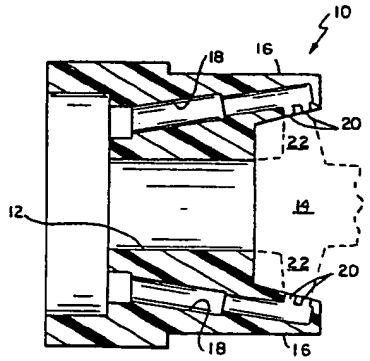
(54) Powder nozzle.

(57) A nozzle for increasing the uniformity of distribution of a powder including a first passageway (12) through which a bearing fluid stream with the powder entrained in it is emitted and a pair of second passageways (18) for directing a fluid compatible with the bearing fluid stream with the powder entrained in it onto opposite surfaces of the bearing fluid stream with the powder entrained in it.

FIG. 1



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This invention relates to the uniform distribution of pulverulent materials, hereinafter generally referred to as powder, in bearing streams. It is disclosed in the context of atomizing and fan shaping nozzles for streams of coating powders, but is believed to be useful in other contexts as well.

Various dispensers for coating powders are known. There are, for example, the dispensers illustrated and described in the following U.S. Patents: 5,022,590; 4,993,645; and 4,788,933. Additionally, various dispensers for atomizing and dispensing liquid coating materials are known. There are, for example, the dispensers illustrated and described in U.S. Patents: 3,251,551; 3,837,573; 3,938,740; 4,232,832; 4,294,411; 4,713,257; 4,842,203; and, 5,071,074. No representation is made hereby, nor should such a representation be inferred, that a thorough search of all pertinent prior art has been conducted or that no more pertinent prior art exists.

A problem which exists in the dispensing of coating powder is that the coating powder tends not to be uniformly distributed in the stream of bearing fluid, typically compressed air. Effects such as so-called "barber poling," the somewhat helical distribution of the powder borne by the carrier fluid stream, occur in the operation of many coating powder dispensers. Barber poling is quite apparent in the conduit which leads from the powder coating material source, such as a fluidized bed, and the dispenser. If the conduit is transparent or semitransparent, the barber poling can be seen as a somewhat helical distribution of the powder in the conduit. Bends in the conduit between the bed and dispensing device seem to aggravate this condition, presumably because of the destabilizing effects of such bends on the carrier fluid stream velocity profile across the interior cross section of the conduit. In prior art powder dispensing devices known to the applicants, this and other non-uniform distribution phenomena do not necessarily disappear when the powder entraining stream is emitted from the dispensing device. Instead, they can persist, and can result in the non-uniform distribution of the powder coating on articles coated by the powder coating. Although movement of the dispenser can reduce these non-uniform distribution effects, powder coating processes can be made much more effective and results more reproducible by reducing the potential for non-uniformity in the dispensed powder stream. While reducing the possibility of bends, twists and other non-uniformities in the powder coating delivery circuit seems attractive as a technique for reducing such distribution effects, it is difficult to implement in any powder coating installation in which powder dispensers are moved during the dispensing process. Movement practically necessitates conduit flexibility, and conduit flexibility practically dictates bends, twists and other non-uniformities in the delivery circuit. Thus, the best point at which to attack the problem of non-uniformity of coating powder in the delivery stream is where the delivery fluid stream with the powder entrained in it leaves the dispenser.

Fan shaping air has long been used in liquid atomization. The liquid stream, once atomized either pneumatically, hydraulically or by any other technique into a somewhat cone-shaped cloud, has a stream, typically of compressed air, directed against each of two opposite sides of the cone. The cone is thereby flattened, and the effects of such distributional irregularities as "hollowness" of the cone-shaped cloud, which might otherwise result in a "donut" shaped paint particle distribution on a stationary target, are reduced. Such techniques have been practiced in both electrostatically charged and non-charged applications. However, to applicants' knowledge, it has never been proposed to apply this technology to powder coating to cure distributional irregularities in the dispensed powder stream.

According to an aspect of the invention, a nozzle is provided for increasing the uniformity of distribution of a powder across a bearing fluid stream emanating from the nozzle. The nozzle includes means for attachment of the nozzle to a conduit carrying the bearing fluid stream with the powder entrained in it. The bearing fluid ordinarily will be compressed air, or a compressed air fraction such as carbon dioxide, nitrogen, argon, helium, or the like, or mixtures of selected ones of these. A first passageway is provided through which the bearing fluid stream with the powder entrained in it is emitted. The first passageway is in open communication with the conduit when the bearing fluid stream with the powder entrained in it is to be emitted. The nozzle further includes a pair of second passageways for directing a fluid compatible with the bearing fluid stream with the powder entrained in it onto opposite surfaces of the bearing fluid stream with the powder entrained in it substantially as the bearing fluid stream with the powder entrained in it is emitted from the first passageway. The second passageways are coupled to a source of the compatible fluid. This increases the uniformity of distribution of the powder across the bearing fluid stream.

According to another aspect of the invention, a nozzle is provided for creating and non-contact charging of a stream of coating material particles emanating from the nozzle. The nozzle includes means for attachment of the nozzle to a conduit carrying a coating material stream, and a first passageway through which the coating material stream is emitted. The first passageway is in open communication with the conduit when the coating ma-

terial stream is to be emitted. A fluid compatible with the coating material stream is directed from a second passageway onto a surface of the stream of coating material particles substantially as the stream of coating material particles is emitted from the first passageway. The second passageway is coupled to a source of the compatible fluid. A charging electrode is disposed at least partly within the second passageway. Means are provided for coupling the charging electrode to a potential source. Flow of the compatible fluid through the second passageway causes charge to be transferred from the charging electrode to the coating material particles as the compatible fluid directed from the second passageway impinges upon the stream of coating material particles.

Illustratively, the nozzle further comprises a pair of charging electrodes disposed on opposite sides of the first passageway from each other, and means for coupling the charging electrodes to a source of electrostatic potential.

Additionally, illustratively, the charging electrodes are at least partly disposed within respective ones of the second passageways.

The invention may best be understood by referring to the following description and accompanying drawings which illustrate the invention. In the drawings:

Fig. 1 illustrates a longitudinal sectional view through a powder dispensing nozzle constructed according to the present invention;

Fig. 2 illustrates a longitudinal sectional view through another powder dispensing nozzle constructed according to the present invention;

Fig. 3 illustrates a front elevational view of the nozzle illustrated in section in Fig. 2, taken generally along section lines 3-3 thereof;

Fig. 4 illustrates a longitudinal sectional view through another powder dispensing nozzle constructed according to the present invention; and,

Fig. 5 illustrates in block and schematic form a system employing a nozzle according to the present invention.

The nozzles of the drawings are intended to be mounted on any suitable dispenser of a stream of a carrier gas, typically air, entraining a coating powder directed at an article to be coated by the powder. Such a dispenser can be of the so-called manual, that is, hand-triggered and aimed, or automatic, that is, machine-triggered and aimed or stationary, type. An illustrative, but not limiting, example is the dispenser of U.S. Patent 5,022,590. The nozzle 10 of Fig. 1 is one in which the dispensed powder is not electrostatically charged. Such a nozzle 10 can be used, for example, to dispense coating powder onto articles which have been preheated so that the dispensed, typically resin-based, powder will fuse at least to some degree on impact with the preheated articles and stick to them. Ordinarily some subsequent processing of the articles will be undertaken, such as exposure to additional heat to fuse the powder coating more fully and render the coating substantially continuous. In any event, the nozzle 10 includes a central passageway 12 through which powder in an entraining air stream 14 is dispensed. Horns 16 are disposed diametrically from each other adjacent passageway 12. A separate channel in the dispenser provides fan air to fan air channels 18 in horns 16. Channels 18 open to atmosphere at locations 20 on opposite sides of the powder entraining air stream 14 exiting from nozzle 10. Air pressure to, and flow 22 from, the channels 18 can be controlled concurrently with, or separately from, the stream 14. The impingement of streams 22 on the opposite sides of stream 14 "homogenizes" the powder particles carried by stream 14, distributing those particles across the transverse section of stream 14 more uniformly and reducing distributional anomalies such as barber poling in the powder borne in stream 14.

The nozzle 30 of Figs. 2-3 is one in which the dispensed powder is electrostatically charged. Such a nozzle 30 can be used, for example, to dispense coating powder onto articles which have not been pretreated so that the dispensed power will stick to them. Instead, the powder is charged by corona discharge from electrodes 32 provided on opposite sides of a central passageway 34 and spaced equidistantly from the two horns 36 with which the nozzle 30 is provided. The powder is typically a resin or porcelain powder and, as such, is not electrically very conductive. Consequently, the charge which is imparted to it does not readily migrate from it even when the charged powder grains strike a typically grounded, electrically highly conductive, for example, unfinished steel or aluminum, article to be coated by the powder. The powder grains consequently are held on the surfaces of the article by electrostatic attraction until the powder can be fused into a substantially continuous coating by subsequent processing. Ordinarily some subsequent processing of the articles will be undertaken, such as exposure to additional heat to fuse the powder coating and render the coating substantially continuous.

The arrangement of Figs. 2-3 places the electrodes 32 out of the powder laden stream 37 so that the electrodes 32 are not as likely to be eroded by the sometimes highly abrasive powder. In any event, the nozzle 30 includes the central passageway 34 through which powder in the entraining air stream 37 is dispensed. Horns 36 are disposed diametrically from each other adjacent passageway 34. A separate channel in the dispenser provides fan air to fan air channels 38 in

horns 36. Channels 38 open to atmosphere at locations 40 on opposite sides of the powder entraining air stream 37 exiting from nozzle 30. Air pressure to, and flow 42 from, the channels 38 can be controlled concurrently with, or separately from, the stream 37. The impingement of streams 42 on the opposite sides of stream 37 homogenizes the powder particles carried by stream 37, distributing those particles across the transverse section of stream 37 more uniformly and reducing distributional anomalies such as barber poling in the powder borne in stream 37.

The nozzle 50 of Fig. 4 is one in which the dispensed powder is electrostatically charged. The arrangement of Fig. 4 places the electrodes 52 out of the powder laden stream 54 so that the electrodes 52 are not as likely to be eroded by the powder. The nozzle 50 includes the central passageway 56 through which powder in the entraining air stream 54 is dispensed. Horns 58 are disposed diametrically from each other adjacent passageway 56. A separate channel in the dispenser provides fan air to fan air channels 60 in horns 58. Channels 60 open to atmosphere at locations 62 on opposite sides of the powder entraining air stream 54 exiting from nozzle 50. Air pressure to, and flow 64 from, the channels 60 can be controlled concurrently with, or separately from, the stream 54. Electrodes 52 are exposed to the flows 64 in channels 60 and are thus continuously "washed" by flows 64. At the same time, flows 64 pick up charge from electrodes 52 and transfer it to the powder in stream 54 as they impact against the opposite sides of stream 54. This increases the electrical charge-to-mass ratio of the dispensed powder. The impingement of streams 64 on the opposite sides of stream 54 also homogenizes the powder particles carried by stream 54, distributing those particles across the transverse section of stream 54 more uniformly and reducing distributional anomalies in the powder borne in stream 54.

Fig. 5 illustrates a system employing the nozzle of Fig. 4. A manual powder dispenser 80, illustrated in broken lines, dispenses a stream of compressed air, entraining a coating powder from a fluidized bed 82 directed at an article 84 to be coated by the powder. The illustrative dispenser 80 is of the general type illustrated and described in U.S. Patent 5,022,590. High electrostatic potential to charge the dispensed powder is provided to the electrodes from an electrostatic potential source 88 through a resistor to a charging ring of the type described in U.S. Patent 5,022,590. The charging ring can be constructed from an electrically conductive or semiconductive filled or unfilled resin. The nozzle itself and its holder ring can be constructed from an electrically non-conductive filled or unfilled resin such as polytetrafluoroethylene. Air pressure to, and flow from, the fan homogenizing channels can be controlled 90 separately from the control 92 of the powder bearing stream.

In the illustrated embodiments, the powder passing through the illustrated nozzles does not contact the air horns through which the shaping and atomizing air is directed onto the dispensed powder stream. Impact fusion, the buildup of partially cured or gelled powder caused by heat buildup due to contact friction, on the air horns is thus substantially reduced. Such impact fusion otherwise might cause buildup to a heavy thickness which can then slough off back into the stream of atomized powder and be conveyed to the article being coated and create a blemish in its coating.

In addition, in the Figs. 2-4 embodiments, the charging electrodes are also located outside the powder-bearing air stream. The potential for impact fusion buildup on the electrodes is thus also substantially reduced. Further, the impact fusion of powder on prior art electrodes tended to reduce the charging efficiency of these electrodes. That drop off in efficiency is substantially illuminated by placing the charging electrodes as illustrated in Figs. 2-4.

Further, with the embodiment illustrated in Fig. 4, the preferred placement of the electrodes substantially completely within the shaping air channels provides the added benefit of continuously rinsing the electrodes. This ensures that the electrodes supply charge to the atomizing/shaping air stream at substantially their maximum capability for transfer to the atomized powder.

Claims

1. A nozzle for increasing the uniformity of distribution of a powder across a bearing fluid stream emanating from the nozzle, the nozzle including means for attachment of the nozzle to a conduit carrying the bearing fluid stream with the powder entrained in it, a first passageway through which the bearing fluid stream with the powder entrained in it is emitted, the first passageway in open communication with the conduit when the bearing fluid stream with the powder entrained in it is to be emitted, a pair of second passageways for directing a fluid compatible with the bearing fluid stream with the powder entrained in it onto opposite surfaces of the bearing fluid stream with the powder entrained in it substantially as the bearing fluid stream with the powder entrained in it is emitted from the first passageway for increasing the uniformity of distribution of the powder across the bearing fluid stream, and means for coupling the second passageways to a source of the compatible fluid.

2. The nozzle of claim 1 and further comprising a pair of charging electrodes disposed on opposite sides of the first passageway from each other and means for coupling the charging electrodes to a source of electrostatic potential.

3. The nozzle of claim 2 wherein the charging electrodes are at least partly disposed within respective ones of the second passageways.

4. A nozzle for creating and non-contact charging of a stream of coating material particles emanating from the nozzle, the nozzle including means for attachment of the nozzle to a conduit carrying a coating material stream, a first passageway through which the coating material stream is emitted, the first passageway in open communication with the conduit when the coating material stream is to be emitted, a second passageway for directing a fluid compatible with the coating material stream onto a surface of the stream of coating material particles substantially as the stream of coating material particles is emitted from the first passageway, means for coupling the second passageway to a source of the compatible fluid, a charging electrode disposed at least partly within the second passageway, and means for coupling the charging electrode to a potential source, flow of the compatible fluid through the second passageway causing charge to be transferred from the charging electrode to the coating material particles as the compatible fluid directed from the second passageway impinges upon the stream of coating material particles.

5. The nozzle of claim 4 comprising a pair of such second passageways disposed on opposite sides of the first passageway from each other.

6. The nozzle of claim 5 further comprising another charging electrode, the charging electrodes being at least partly disposed within respective ones of the second passageways, and means for coupling both of the charging electrodes to the potential source.

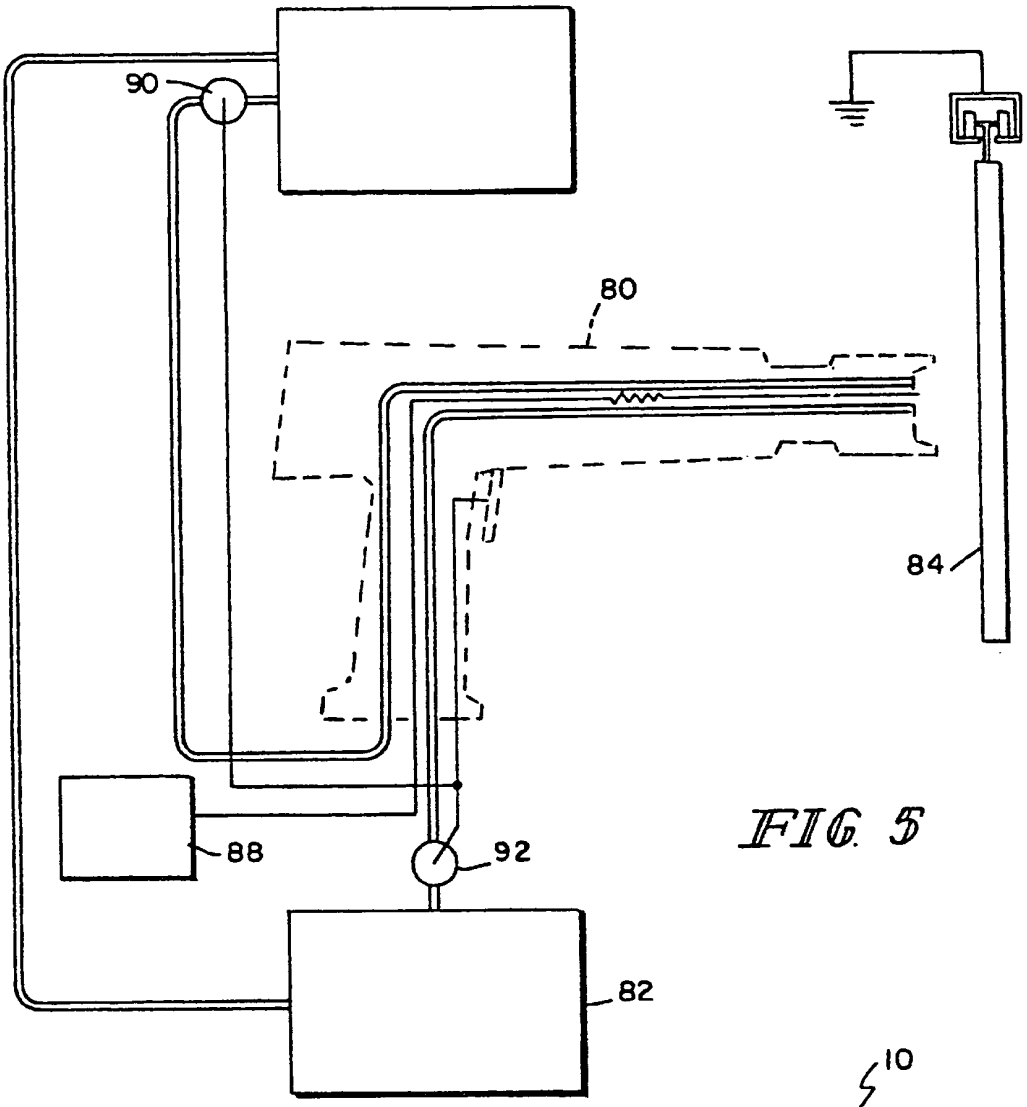

FIG. 5

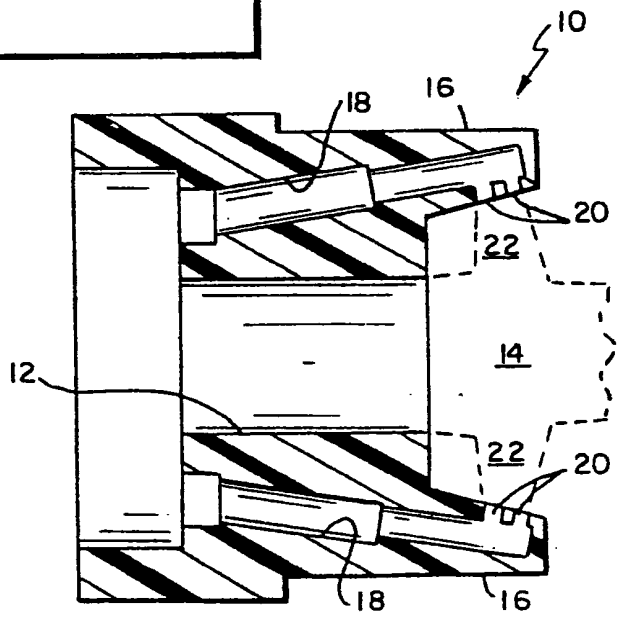

FIG. 1

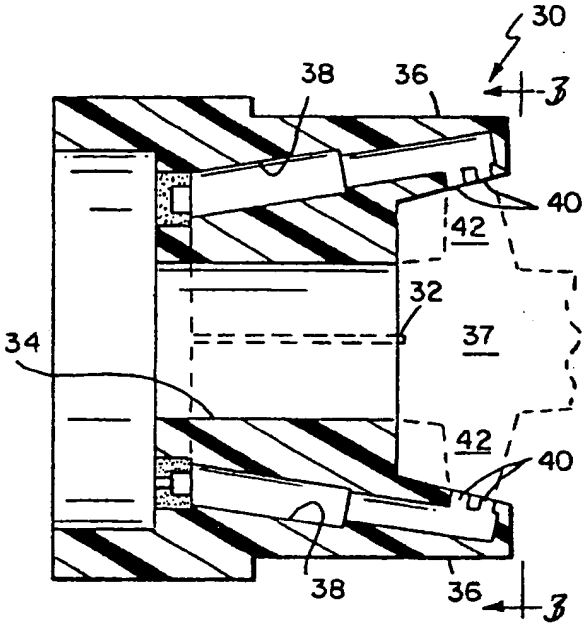

FIG. 2

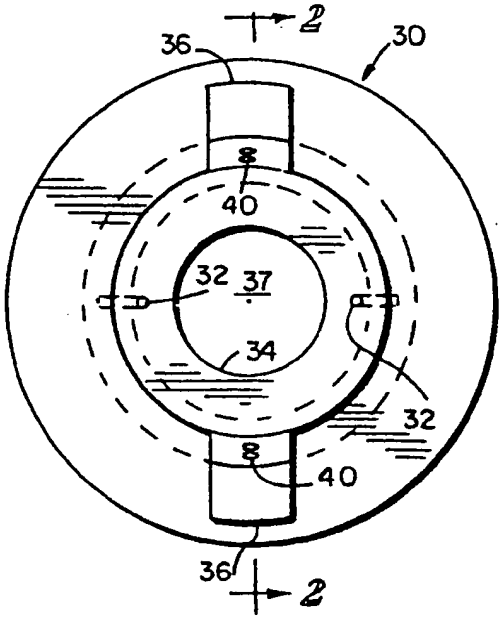

FIG. 3

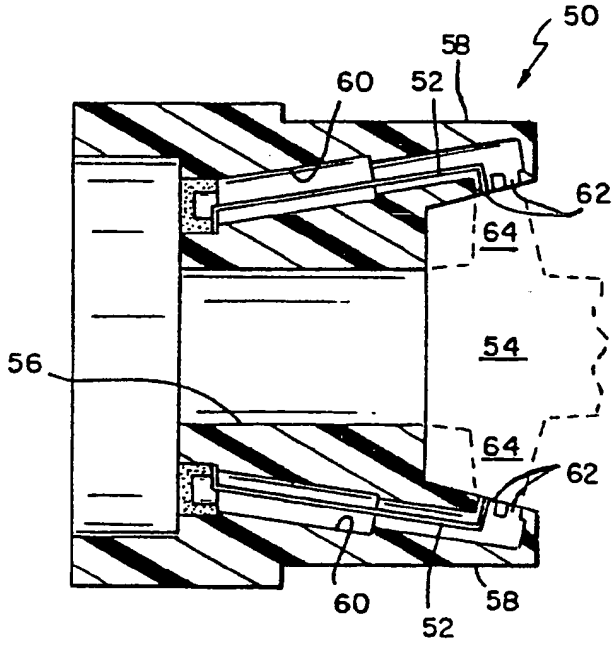

FIG. 4

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 680 790 A3

(12) EUROPEAN PATENT APPLICATION

(88) Date of publication A3:
12.06.1996 Bulletin 1996/24

(43) Date of publication A2:
08.11.1995 Bulletin 1995/45

(21) Application number: **95104359.5**

(22) Date of filing: **24.03.1995**

(51) Int. Cl.[6]: **B05B 7/08**, B05B 5/03, B05B 5/053

(84) Designated Contracting States:
BE CH DE ES FR GB IT LI NL

(30) Priority: **05.04.1994 US 222897**

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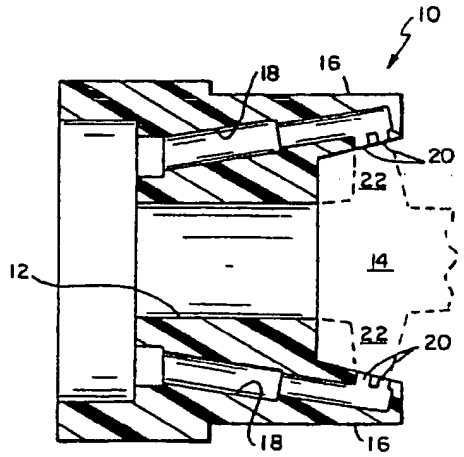
(54) Powder nozzle

(57) A nozzle for increasing the uniformity of distribution of a powder including a first passageway (12) through which a bearing fluid stream with the powder entrained in it is emitted and a pair of second passageways (18) for directing a fluid compatible with the bearing fluid stream with the powder entrained in it onto opposite surfaces of the bearing fluid stream with the powder entrained in it.

FIG. 1



EP 0 680 790 A3

Printed by Rank Xerox (UK) Business Services
2.12.1/3.4

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 10 4359

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	DE-A-24 46 022 (ESB G.F. VÖHRINGER) * page 2, paragraph 1 * * page 7, paragraph 2; figure 2 * ---	1-6	B05B7/08 B05B5/03 B05B5/053
X	FR-A-2 605 533 (SAMES) * page 5, line 6 - line 13; claim 7; figures 1,2,4 * -----	1-6	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6) B05B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	16 April 1996	Guastavino, L

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